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HOUSE-AIR

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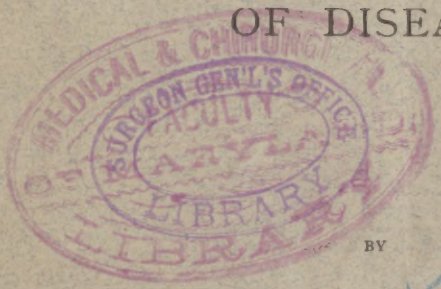
CAUSE AND PROMOTER

OF DISEASE.



BY

FRANK DONALDSON, M. D.

PROFESSOR OF PHYSIOLOGY AND HYGIENE, CLINICAL PROFESSOR DISEASES OF THROAT AND CHEST, UNIVERSITY OF MARYLAND.

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House-Air the Cause and Promoter of Disease.

By Prof. FRANK DONALDSON, M.D., University of Maryland.

So much has been written of late years about the necessity of ventilation, that we feel we ought to apologise for calling the attention of the public to facts with which all should be familiar. We would not have selected this subject had we not been so frequently struck with the deplorable ignorance, everywhere met with, of the simplest principles of hygiene in connection with atmospheric air, and the consequent violation of its plainest requirements. Contaminations of food or water are more readily recognised, because they offend the taste; but impurities of the air are frequently not appreciated by the senses, and their injurious effects are more gradual and more insidious. *Practically, the community is not alive to the fact that impure air is a poison, and is directly or indirectly the cause of great mortality;* this, too, notwithstanding the fact that the necessity of pure air for the integrity of function of human beings has been recognised for many years. The explanation of this as a scientific proposition was not known until the latter part of the last century (1774), when Priestley discovered oxygen, and Lavoisier discovered the gases of which the air is composed. Lavoisier demonstrated that its oxygen converted the venous into arterial blood. Since that time numerous experimenters and men of science have devoted their time and labor to ascertain the exact relation that the

air bears to the body. Popular essays, as well as scientific articles, have been published to show how vital it is to health that it should be always as pure as Nature has given it to us. These have had some beneficial effects, as shown in the construction and arrangement of large public buildings, such as jails, hospitals and almshouses; but in relation to private houses they have done but little. The community generally look upon sanitarians as a professional class, who have hobbies about which they continually write, and think that fresh air and its influence is one of them. Many persons appear to have literally an abject fear of draughts of cold air, and to lose sight of the less apparent, but more dangerous effects of impure air. We are not, however, to be thus discouraged in our efforts to lessen preventible causes of mortality, and we must continue in our efforts to arouse the public to the prevalent suicidal neglect of proper health precautions.

For the proper discussion of our subject, we propose briefly to explain —

1. What pure air is.
2. Its physiological action.
3. How it becomes vitiated and poisonous in houses.
4. The diseases it produces.

In conclusion, we shall offer some practical suggestions as to the best methods of keeping it pure.

Composition of Atmospheric Air.

Air is composed of one-fifth of oxygen, four-fifths of nitrogen, with an almost infinitesimal proportion of carbonic acid — $\frac{1}{2500}$ of the atmosphere — with very slight traces of ammonia; aqueous vapor in the proportion of $\frac{1}{2}$ to 2 per cent. This last fluctuates greatly, and is mainly influenced by temperature; at a given temperature, air cannot contain more than a certain proportion of moisture, for it saturates it; generally the air contains from 50 to 75 per cent. of the amount requisite for complete saturation — the average, according to Prof. Wilson, being 1.46 to 100 parts. If the quantity be not within these limits, the air is either unpleasantly dry or moist. The ammonia does not exceed one part in a million parts of air.

We have Ozone, or oxygen in an allotropic condition, with, as shown by the spectroscope, everywhere present, chloride of sodium. With this vast ocean of air, fifty-five miles in depth, our little planet is surrounded. It never leaves it as it goes on its course around the sun.

Thus Nature in her bountifulness has furnished us with an inexhaustible supply. Its composition, so far as regards its essential elements, is the same in all parts of the globe and at all elevations within our reach. The outside air frequently contains other aëriform substances, and some of a solid or fluid nature — such as the gases generated by combustion and similar processes; traces of nitric and acetic acids, and hydrosulphate of ammonia, and, near the ocean, muriatic acid and iodine; exhalations from the organic kingdom, morbid emanations from men, animals and plants, when suffering from disease and as the result of decomposition after death; carbonaceous matters, infusoria, and other microscopic organisms; pollen of plants, spores and germs of some low orders of living beings, and finely subdivided organic matters — dust, invisible malaria, &c. These must be regarded as accidental rather than normal constituents.

The currents of air and the winds, the heat and electricity, keep the atmospheric outdoor air in almost ceaseless motion, and these extraneous matters are swept away. The quantity of oxygen is always sensibly diminished in the air of towns, according to Prof. Wilson. The vegetable kingdom, by its absorption of carbonic acid and giving off of oxygen, contributes in no small degree to the purity of the external air. Moreover, the air contains within itself the means of its purification. By a process of oxidation it converts all organic substances exposed to it into simpler forms of matter, such as carbonic acid, nitric acid, water, &c. Thanks to Schönbein's grand discovery of Ozone, we now know this agent as the one by which the impurities are oxidised. It is universally admitted to be an indispensable agent, and to be derived from the oyygen of the atmosphere and certain electro-chemical decompositions, and to consist of that element freed from its combinations and thrown into a peculiar dynamic and allotropic condition of the nature of polarisation, by means of

those currents of electricity at all times flowing silently through the air.

Its Physiological Effects.

Air is the chief factor of life, and its use in breathing is the first and the very last act of our existence as independent beings. We can live a certain period of time without food, but we cannot without air. We must breathe from fifteen to twenty times per minute, and not less than 20,000 times in 24 hours.

To understand thoroughly the effects of impurities of the atmosphere, we must glance, although hurriedly, at the physiological effects of pure air. The *oxygen* is the element which is efficient in respiration. It is important that it should be understood that the oxygen we breathe enters not only the lungs, but passes, while in the lungs, through the walls of the blood-vessels, and becomes incorporated with the blood, and permeates every tissue and part of the body, and is absolutely necessary for their physiological functions. *Respiration is not confined to the lungs, but extends throughout the body.* In the tissues oxygen is given off, and carbonic acid, the result of the disintegration, and, consequently, an impure and effete gas, formed in the tissues, passes into the blood and colors it dark. In the lungs there is absorption of oxygen and discharge of carbonic acid. The cause of this *external respiration* is explained by physiologists to result from the differences between the tension of the gases of the blood and the atmosphere, respiration equalising these tensions. An animal, human or other, placed in a confined space, can consume almost the whole of the oxygen which the air contains, whilst the evolution of carbonic acid is very soon stopped by an equalisation of the tensions taking place. *The essence of respiration consists in the interchange of these gases* — the appropriation of oxygen and exhalation of carbonic acid. If this interchange does not take place, life becomes extinct. Any impairment of the process, or any impurity of the air, deranges all the functions of the body, such as those of the stomach, nervous system, the brain, the kidneys, &c. This then must never be lost sight of, that the lung process is only a *very small part* of respiration, which includes the whole organism. Without the

due amount of oxygen, the blood does not circulate well in the minutest blood-vessels, and every function is deranged. *We have thus an internal atmosphere of the tissues, as well as an external one.* We pant for breath because our organs and structures everywhere demand oxygen.

At each inspiration the volume of oxygen absorbed is five per cent. of the volume of atmosphere, and the exhalation of carbonic acid four per cent. In the expired air we not only have this amount of carbonic acid, but we have ammonia, and aqueous vapor loaded with organic matter. This last substance can be easily shown by breathing on a sponge, or by allowing the breath to be condensed in a glass vessel; putrefaction, a property characteristic of organic substances, will take place. In the open air the expired air with its impurities ascends and is scattered far and wide; it is purified, and we do not rebreathe it, for we are in literally an ocean of fresh air. The injurious gases become diffused and decomposed; animal emanations are absorbed in vegetation; suspended substances fall to the ground, and organic substances are oxidised, and thus rendered harmless.

Air is not only essential when taken into the organism, but *atmospheric pressure* over every point of the body knits the animal framework firmly together. When we ascend mountain heights, where the atmosphere is lighter, and consequently the pressure diminishes, we suffer with oppression of breathing, palpitation, and many painful symptoms. Under the normal atmospheric pressure the lungs are filled with air as the walls are expanded. These mechanical effects are essential.

We must also bear in mind the physical influence of the atmospheric air in regulating the *animal temperature.* Radiation of the animal heat is from all points into the external air. If the external air be cooled far below the level of the body, then the radiation is so vigorous that we arrest thereby the vital processes of the body; the grand nutritive acts cannot go on, and we must die. *Thus air is food—the first and the last we partake of.* Its oxygen is carried by those wonderful little missionaries, the red globules, throughout every portion of the body, and we live upon it. Without

air, food through the stomach cannot be assimilated. "Starvation is a matter of days without solids, hours without liquids, but of minutes without air." (Parkes.)

House Air.

Dr. Parkes' estimate of 3000 cubic feet of air per head each hour is generally believed to be correct. If the space is 1000 cubic feet, the air must be renewed three times every hour. This, Dr. Parkes tells us, is all that can be borne, and more frequent renewal will make too active air-currents or draughts. House-air is simply air confined within four walls. Wherein does it differ from outside air? The winds and the outside currents do not reach it; and unless we take especial pains to renew it, it becomes vitiated.

Every human being, every pet animal, in a house, consumes the air; and when once thus used, it becomes unfit for further use, because it contains effete substances, the result of the wear and tear of the organism. These when rebreathed enter the lungs, and with the air penetrate into the blood, and thence pass to the structures of the body. The exhaled air contains less oxygen by nearly one-fourth than the inspired column; thus every breath takes away from the really nutritive element of the air. The tissues suffer primarily from deficient supply of oxygen. An adult man exhales on an average .6 cubic feet of carbonic acid per hour. The limit of maximum impurity that can be borne is .7 carbonic acid per 1000 volumes. According to Dr. Carpenter, an adult man gives off 160 grains of carbon per hour. Dr. Parkes gives the average amount of carbonic acid exhaled by an adult in the twenty-four hours as sixteen cubic feet.

The air as it is expired is heated. Hartley states the bodily heat of one man will cause a rise of temperature of 150 cubic feet of air, equal to 173°. Hence the great heating effect of a mass of human beings packed closely together in badly ventilated and ill-lighted buildings.

The expired air contains ammonia in appreciable quantity. The inmates of the famous Black Hole of Calcutta suffered from it. One of the sufferers described the intolerable irrita-

tion caused by the inspired air as though the face was held over hartshorn. Of the one hundred and forty-six persons immured, in two hours fifty were dead. The next morning only twenty-three remained alive, and nearly the whole of these suffered from putrid typhus fever, of which many died. We know the irritating influence of ammonia. According to Dr. Richardson, it tends to hold the blood in a state of fluidity. It also interferes with the process of oxidation of organic matter, so that it becomes an antiseptic, and it rapidly decomposes ozone. The breath and the skin further give off compounds of sulphur and ammonia, sulphide of ammonia, which is directly poisonous. The quantity of watery vapor exhaled is estimated at from 25 to 40 ounces in the 24 hours, and requires an average of 210 cubic feet of air per hour to retain it. This vapor is loaded with organic matter, which is especially deleterious to health. It has a very fœtid smell when it accumulates, and is but slowly oxidised. It is believed (Prof. Wilson) to be molecular, and may be said to hang around a room like clouds of tobacco smoke. Its odor is difficult to get rid of, even after free ventilation. It darkens sulphuric acid and discolorises solutions of permanganate of potash. When put in pure water it becomes offensive. In sick-rooms it is associated with pus-cells and other emanations of disease.

It has been demonstrated that the amount of organic matter in air vitiated by respiration is found to increase as the carbonic acid increases. Dr. Parkes states, and others have confirmed his statement, that it becomes perceptible to the sense of smell when the carbonic acid in an inhabited room amounts to .7 per 1000 cubic feet of air. Tyndall has shown the amount of this organic dust, which is nothing more nor less than organic poison, everywhere present indoors. The philanthropist, John Howard, stated that his clothes became so offensive from prison air that he could not ride in coaches, but had to travel on horseback. The leaves of his memorandum-book were so tainted that he had first to spread them open for an hour or two before an open fire before he could use them. Such are the emanations of effete matter which are constantly being given off from organised beings and their excreta. These exhalations, though of a highly putres-

cent character, especially during disease, and escaping into the atmosphere, under ordinary circumstances are not very cognisable by the senses, except when given off as one or other of the numerous family of volatile alkaline principles. In cold climates like that of Russia, a process goes on during the prolonged winter which exhibits very clearly the large amount of organic matter diffused in human exhalations. The moisture given off by the lungs and skins of the imprisoned inmates of the dwellings of the lower orders in the north of Russia is gradually condensed and frozen on the insides of the windows, where it is often allowed to remain, undergoing a slow process of putrefaction (septic fermentation). On the approach of summer the general thaw causes the melting of this deposit, and thereby setting free the products of decomposition, gives rise to certain most offensive odors, for which the abodes of the Russian peasantry, at the breaking up of the ice, are notorious. (Condy). So charged with this azotised matter is the air which we expire, that if we breathe into a jug of water, putrefactive decomposition is readily perceived. Dr. R. Angus Smith has estimated the quantity as 3 per 1000. It is to impurities of this nature that we attribute contagion and infection. It settles in houses, and gets into carpets and woollen materials, and in niches amid dust and dirt. Impurity of air is frequently due to impurity of floors, walls and furniture. *The air of a room can never be pure if the room is dirty.* Cleanliness is necessary to our physical health, and, as we have always been taught, is next to Godliness!

Our means of illumination by gas destroys an immense quantity of the air of houses, and leaves injurious products of combustion. One cubic foot of coal-gas destroys the oxygen of eight cubic feet of air in combustion, and produces about two cubic feet of carbonic acid, besides other impurities. A common gas-burner burns about three cubic feet of gas per hour. How long can the air remain pure when there are present several persons, each consuming sixty gallons of it per hour, with gas-jets each destroying as much air as eleven men—660 gallons per hour? If stoves are used, the consumption of air is fearful—not less than 15,000 gallons of air per hour. *It is impossible to breathe, or have fires or lights, without robbing air of*

its oxygen and loading it with impurities. When Dalton (as given by Lewes) analysed the air of a room in which during two hours fifty candles had been burning and five hundred persons breathing, he found that instead of the proportion of carbonic acid being only two gallons in five thousand of air, it was not less than one gallon in every hundred. Leblanc analysed the atmosphere of three hospitals in Paris, and found that they contained respectively five, ten, and twelve times as much carbonic acid as the air of the streets.

Frequently we have in houses, from the combustion of coal and charcoal, the *oxide of carbon*, which is a deadly gas, with its characteristic blue flame. It renders the blood corpuscles red, and interferes with the absorption of oxygen. If we breathe this gas, even in very small quantities, it is poisonous. No ventilation will prevent us from being poisoned if we are in a room where coke or charcoal fumes are allowed to escape. Dr. Marye and Mr. Lewes both give instances of fatal asphyxia from this cause, although windows were open and air was circulating. Our ordinary gas, escaping into the air of rooms, contaminates; fortunately for us, its smell is unmistakable when it is only one part in a thousand; it becomes very offensive when it is $\frac{1}{750}$ or $\frac{1}{500}$.

Another source of impurity in house-air is the animal odors proceeding from our kitchens. They float in the atmosphere, and render the air not only disagreeable at the time, but they are deposited in carpets and closets, old clothes, &c., &c. They undergo decomposition, and promote, if they do not actually cause, typhoid fever and other Filth diseases. In Dr. Richardson's model City of Health he wisely places the kitchens on the uppermost floors. In a sanitary point of view this is an admirable arrangement. It secures an abundance of light, and the culinary odors ascend and can only annoy the passing birds. With the modern easily-worked hydraulic elevators this plan can be economically carried out.

Sewer-Gas.—House-air is frequently rendered very pernicious by sewer-air. The gases generated by the decomposition of excremental matter may be enumerated as carbonic acid, nitrogen, sulphuretted hydrogen, light carburetted hydrogen, and ammonium sulphide. The peculiar fœtid smell of sewer-gas is

owing to the presence of organic matter, the exact chemical composition of which has not been determined. Like other organic effluvia, it promotes the growth of fungi, renders milk sour and taints meat. Prof. Brewer, of Yale, remarks: "The sense of smell tells us that there are organic gases and compounds, never yet isolated, of whose composition and properties, other than smell, we are entirely ignorant; indeed, we are ignorant of the composition of most of the smells of putrescent matter."

Ferments.— Of all the poisonous elements in house-air there are none so productive of disease as those now recognized as the *morbific ferments or contagia* in connection with *Filth*. These are not gaseous, but solid in their nature; living organisms, microscopical in their size; indefinitely self-multiplying, and ordinarily developing with fearful rapidity. These ferments are the factors of specific chemical processes — the ordinary septic (putrefactive) ferment, always present in putrefactive changes in decaying animal matter. Filth produces fermentative (zymotic) diseases, which are known as infectious diseases, such as cholera, epidemic diarrhœas, puerperal fever, erysipelas, pyaemia (pus in the blood), septicaemia (putridity of the blood), typhoid fever, &c.

Dr. Klein, Prof. Sanderson of London, and others, have by their experimental pathological researches shown that in the common septic and other ferments there are positive specific disease-producing poisons. These microphytes, apparently of the lowest form of vegetable life, multiply in innumerable swarms in the body and out of the body. Moisture is their normal medium, and the humid air of sewers and drains scatters them far and wide, and thus spreads the fatal seed of infection. Diseases are by these means insidiously disseminated.

The *absence of sunlight in houses* renders the air impure. The sun's rays not only prevent dampness and mustiness, but they purify the atmosphere by destroying organic matter. Organic poisons of infectious diseases, and even the Woorara snake poison, are rendered inert when exposed to sunlight. We will not be so impolite as to say that our fair housekeepers "love darkness rather than light," but they certainly utterly ignore habitually the beneficial, healthful influence of daylight.

Condy makes the statement that Ozone has never been detected inside inhabited houses, although in many instances the external air close to the windows has manifested it abundantly. He considers it the great scavengering principle of Nature, and adds that without it the atmosphere would ultimately become incapable of sustaining life. It is so opposed to all foul and effete products of living organisms, that its presence in any given locality may be taken as proof of the absence of those impurities which interfere with the fitness of the air for respiration and the maintenance of health. Dr. Ben. W. Richardson states that when the oxygen of air has lost its activity and has become ant-ozonised, it will not sustain life; but if electrical discharges are passed at intervals through the oxygen, it will continue to sustain life.

As we are discussing only house-air, we need not refer to the mechanical impurities in factories and manufactories, which cause so much disease; but in confined air indoors we have foreign particles of woollen and other materials floating in the air and making mischief. We meet with, moreover, arsenical poisoning from green wall-papers, besides the organic paste used in papering. We have the emanations from uncovered night-vessels, spittoons, and from filth of various kinds, amounting sometimes to pounds, accumulating in the carpets and the furniture. We inhale musty smells with stagnant air. We breathe the overheated dry atmosphere—all contributing to render the air less sustaining than it ought to be. *All these impurities, with their deleterious influences, accumulate in dwelling-houses unless the air is frequently renewed by efficient ventilation.*

Diseases produced by House-Air.

We have not exaggerated in speaking of the impurities of house-air. That they may be removed there is no doubt; but that ordinarily they are not, even in the houses of the better classes, is a clearly ascertained fact. The air in inhabited rooms, under the most favorable circumstances, can with difficulty be maintained in as pure a condition as the external air; yet the organic processes of the body are absolutely dependent upon the purity of the atmosphere. Fortunately for us, we do

not remain in it always; but those who do, or who are much indoors, show its effects by their general weakness, their pallor, their bloodless condition, their susceptibility to atmospheric changes, their morning malaise, headaches and dyspepsia. Indoor occupations predispose to all mal-nutritive diseases. Dr. Richardson's statistics showed that of 515 cases of Consumption at his dispensary, more than two-thirds were of persons of indoor occupations.

Vitiated air is frequently the direct cause of Consumption, the great scourge of the human race. Is it to be wondered at? When persons are deprived of sunlight, of exercise and of fresh air, their appetites fail; they lose their relish for food, and consequently they are insufficiently nourished. We have shown elsewhere (Amer. Health Ass. Reports, 1875) that pulmonary consumption is essentially a disease of general nutrition, mostly an acquired disease; that the proclivity only is hereditary, but the development is from violations of the simplest laws of health, principally from impure air and absence of sunlight. P. Niemeyer in a recent article takes this view, and shows its correctness by the fact that the deposit first appears in the apices of the lungs—a portion of the organ which is not affected by hereditary pathological processes. MacCormac (on Consumption) tells of a family in which father, mother and six children died of consumption; the seventh son alone survived. He, having quitted the paternal roof and calling, went to sea. The parents and six children lived in narrow quarters, the air of which was quickly vitiated by a large number of persons breathing it; they slept in dusty rooms, with windows closed lest they should take cold. The seventh son quitted the unhealthy locality, had exercise in the open air, became vigorous and healthy and escaped consumption. We frequently meet with just such cases in daily practice. The dust and mucus of the throat and air-tubes collect in the finer air-cells, close them up, and consumption follows.

Dr. Grey (as quoted by Dr. J. R. Black) gives the following table of lung diseases, based upon measurements of the air capacity of rooms occupied by letter-press printers, and the number of compositors in each:

	Number per cent. spitting Blood.	Subject to Catarrh.
104 men having less than 500 cubic feet of air to breathe.	12.50	12.50
115 men having 500 to 600 cubic feet of air to breathe.	4.35	3.48
101 men having more than 600 cubic feet of air to breathe.	3.96	1.98

A demonstration this of the effect of deficient supply of air in development of consumption. Two thousand cubic feet per head per hour is the minimum Dr. Parkes thinks ought to be given. In very many cases that much is not given in 24 hours, and continuously for years. How can children grow up otherwise than delicate?

Scrofula, a disease of the glandular system of growing children, is caused and promoted by vitiated indoor house-air. If there exists a predisposition to any organic disease, that predisposition is developed into its actual manifestation. If there is general constitutional delicacy, it is increased. Hysteria, in all its hydra-headed forms, is fostered by confinement within doors. What is popularly termed biliousness is frequently caused by house-air, and is always made worse by staying indoors. Persons of rheumatoid or gouty proclivities are apt to have attacks when remaining long indoors; which attacks are cured by purer and freer air.

Is it surprising that air that has been breathed, or consumed by gas or fuel, or that which contains impurities or foreign substances, should produce constitutional weakness, and even tissue-disease? It must be borne in mind that through the lungs they enter the circulation, and are carried throughout the organism. Fine dusty particles of charcoal and other foreign matters thus get into the body. Inflammations result, from mal-nutrition, or shocks which disturb the equilibrium of the organic functions. That foul air has these effects we daily see, for persons who spend much time indoors are much more subject to diseases of these kinds than are persons who live outdoors.

Dr. Parkes has given it as his opinion, that allowing .4 vol-

umes as the average amount of carbonic acid per 1000 volumes of air, this standard ought not to exceed .6 per 1000 volumes, because, when this ratio is exceeded, the organic impurities, as a rule, become perceptible to the senses. The amount of carbonic acid in air vitiated by respiration is a tolerably reliable index to the other impurities. Dr. Angus Smith's rule is an admirable one. "Let us keep our rooms so that the air gives no precipitate when a 10½ ounce bottleful is shaken with half an ounce of clear lime-water."

We are frequently met with the reply to any advice offered as to the danger of rebreathing air, that thousands of people live indoors and live for years. This is true; yet it is not the less true that they are poisoned, because there is an adjustment of the organism to the medium by a gradual depression of the functions. The activity is reduced. Bernard's experiments showed that a vigorous, healthy bird would perish instantaneously in air which would sustain the enfeebled bird for an hour. As Lewes remarks with force, "there is a wonderful elasticity in the organism, enabling it to adapt itself to changing conditions; but a frequent depression of functional activity must be injurious, and fatal if prolonged." If we take any small animal, a mouse for instance, and force it, after putting it into a close box, to breathe exclusively air exhaled from our lungs, it will soon faint, and if we persist in our cruelty it will die. See the pale faces and ill looks of children who sleep with their heads under bed-clothes. Sir James Simpson (quoted by Kingsley) tells of a Christmas frolic, where thirty-six persons danced all night in a small room with low ceiling, keeping the doors and windows shut. The atmosphere of the room was noxious beyond description, and the effect was that seven of the party were soon seized with typhus fever, of which two died. At the Grotto del Cane, near Naples, where Mr. Bergh does not reside, a poor dog is kept, to be stupefied for the amusement of visitors by the carbonic acid gas of the Grotto, and brought to life again by being dragged into the fresh air.

Our houses are not equal to the famous Black Hole of Calcutta, but it is only in degree that they differ. We have shown how they are contaminated by injurious gases. It is

the *organic matters* that we exhale, and the fermentive contagia which are produced to such an extent everywhere, which poison our house-atmospheres. Our house-sewerage is so defective, that insidiously we inhale poisons that propagate, even if they do not produce, typhoid fever, diphtheria, scarlet fever, &c.—filth diseases. *Sewers, it is undeniable, often become the channels through which contagious diseases are propagated.* The air from them, laden with specific, definite poison, easily penetrates, from its greater tension, into dwelling-houses, from imperfectly ventilated drains and imperfect traps. During the summer months, when the high temperature outside forces us to open our windows, these diseases are comparatively rare; but as soon as the first autumnal cool weather comes we close our windows and put down our carpets; then these diseases reappear and spread. It would appear as if the germs, the ferments and organic dust lie dormant in the house-air during the Summer, and in the Fall spring into activity and spread by propagation in stagnant, foul air.

Last year we attended, in consultation, in a large house, an adult with fatal diphtheria. One of the inmates left and stayed elsewhere for over a month, during which time the carpets had been taken up and some of the walls repapered, others whitewashed, and disinfectants had been extensively used. On her return to her old quarters, she went into a room in the back-building, distant some sixty feet from the room where the first patient had died. She took the disease and died in two days—a spark of contagium not removed carrying death before it!

Some years since we went on duty, in the month of March, in a hospital where there had been a number of deaths from typhus fever; we ordered tents to be erected in the yard, and that each case as it appeared should be taken out of the building and laid in these tents. The weather was so cold and damp that large fires were kindled at the doors of the tents. Seventeen cases were so treated, and not one of them died. Why? The medical treatment was very much the same as with the cases which had died indoors. It was the outdoor, pure, well ventilated air which so wonderfully decreased the mortality!

The sick require more air than the well—at least from 3500

to 3700 cubic feet per head every hour. In the Dublin Lying-in Hospital, the deaths of newborn children amounted in the course of four years to 2944 out of 7650 births. After a new and effective system of ventilation was adopted, the deaths in four years amounted to only 279. Thus, more than 2500 deaths, or one to every three births, must be attributed to bad ventilation.

In the badly-ventilated prison of the Leopoldstadt, in Vienna, in the years 1834 to 1847, the proportion of deaths was 86 per 1000; out of which number, 51.4 per thousand were due to consumption; while in the well-ventilated House of Correction in the same city, the deaths were 14 per 1000, of which 7.9 were from consumption. It follows then that 43.5 cases per 1000 were deaths attributable to nothing but foul air.

Before the Crimean war, the health of the British army was very bad; at least two soldiers died for every policeman. Foot Guards, 20.4 per 1000; Infantry, 17.8 per 1000; Metropolitan Police, 8.9 per 1000. The soldiers were picked men, better fed, clothed and lodged; but the air in the barrack dormitories was foul to a disgusting degree, and the air-space insufficient. Now, the death rate amongst soldiers, thanks to sanitary improvements, is no more than that of the police, and not more than one-half it was before. So, in the French army, improved ventilation in barracks has given similar results. The British army, when in the Crimea, were lodged in tents during extremely rigorous weather, yet experienced a wonderful condition of health, such a thing as a cold being an unknown complaint; but when some of the men were placed in huts, which were much warmer, and into which there was a smaller circulation of fresh air, the sick rate increased, and coughs and colds began to appear. (Hartley). Persons who during summer and winter sleep with their bedroom windows more or less open, cannot endure a night spent in a room with chimney closed and the window shut.

But there are poisons in the atmosphere which produce and promote disease, and yet are not known by any odors. "It is," says Dr. Simon, "of the utmost practical importance to recognise, in regard of Filth, that agents which destroy its stink may yet leave all its main powers of disease-production

undiminished. It is certain that the ferments of disease, in doses in which they can fatally infect the human body, are infinitely out of reach of even the most cultivated sense of smell." The bacteria, the corpuscles, organic germs and sporules, give us no warning; neither do the vibrios, micrococci, microzymes, nor the zoogloea, &c. Whether the germ theory of diseases of Dr. Beale, or that held by Burden Sanderson, Lister or Tyndall, is correct or not, we know that the antiseptic method is wonderfully successful, and that the purer we keep the atmosphere the less virulent are the poisons. The poor suffer comparatively but little from enteric (typhoid) fevers. It is only the well-to-do who can have sewers in their houses, and sewers often become the real channels by which the contagium is propagated, in consequence of badly-trapped and imperfectly ventilated drains. During epidemics, parents frequently keep their children in the house, for fear that by walking in the streets they may contract the disease. Never was there a greater error. By staying indoors they breathe the same atmosphere, but with additional impurities—impurities which promote contagion.

Another prominent cause of the unhealthfulness of house-air is the high temperature at which it is ordinarily kept. Day and night the thermometer registers frequently 75°F. or even higher, when 65°F. ought to be the highest for waking hours, unless for very old people or the enfeebled, and 60°F. for sleeping hours. Overheating, especially by dry furnace air, overtaxes the skin and causes coughs, colds, sore throats, &c. "Catching cold" is a misnomer; cool air is healthful, provided the clothing is well adapted for the season. Hot air is relaxing, and renders people too sensitive to the lower temperatures. Especially is this the case with children, who frequently fall victims to the lamentable ignorance of their mothers of the simplest principles of hygiene. They are literally smothered by being forced to breathe devitalised air, and their feeble organisms are exhausted by its high temperature. It saddens one to reflect upon the fearful mortality among the young children in our cities. Nearly one-third die in their first year, and one-half before the end of their fifth year. Vital statistics prove that this results, in a great degree, from preventible causes, and that foul air and excessive heat contribute to it.

Let it be borne in mind that night-air in towns is purer than day-air, because there is less smoke, less dust, and less of foreign substances floating in it. Dry, hot air frequently produces pulmonary hemorrhages—the starting point of pulmonary consumption. When persons are convalescing from diseases, they recover the more rapidly if we can get them out of doors. The fresh air with its ozone soon shows its beneficial effects.

We are all familiar with the fact that house-air promotes diseased conditions. It indisposes the individuals to exercise; it impairs their appetite; it renders their sleep less refreshing, and finally it deprives them of sunlight in a great measure. Thus the blood is rendered paler in color and less rich in red globules. The absence of ozone makes the oxygen less vitalising. Dr. Richardson has shown us, by experiments, that absolutely pure oxygen failed to sustain life until it was subjected to the action of the electric spark, when it regained its activity.

Concluding Suggestions.

After all, we must live in houses; we must be protected. Very true. What then are we to do? *We must try to keep the house-air as near in purity to the outdoor air as possible.* This can only be done by ventilation; by keeping it in motion, and renewing it by air from the outside. In large buildings shafts and mechanical apparatuses of various kinds are employed; but in private houses this cannot well be done. There we must rely mainly upon Natural Ventilation. If the cubic space is small, the renewal of air will necessarily be much more frequent. If the space is only 100 cubic feet the air will have to be renewed thirty times per hour to keep up the standard amount. If 1000 cubic feet is the space, then only three times per hour; if it is 424 cubic feet, six times per hour. This becomes almost impossible without artificial means. Prof. Wilson gives his opinion, that if the space be less than 600 cubic feet, it is difficult to avoid too great draughts. In the crowded dwellings of the poor, the space seldom exceeds 200 to 250 cubic feet; the increased rate of mortality is the result.

The force of gaseous diffusion is not sufficient for a venti-

lating force. The products of respiration and combustion are diffused through the room, but the organic impurities are not taken away. Large rooms are much more easily ventilated; yet we daily see persons from choice living in small apartments. The cubic space is small, and then they fill up the rooms with beds and unnecessary furniture. These impede the currents of air and interfere with ventilation. The smaller the number of corners and surfaces the better.

We should be accomplishing an admirable sanitary reform if we could only persuade housekeepers that, *whenever there are smells of any kind, they are caused by organic particles floating in the atmosphere which may produce disease.* To test the purity of the air of a room, it is a good rule to go out for ten minutes into the outdoor air and then return. If it seems close, or odors are perceived, the windows must be opened. If on again shutting them, the impurities are still cognisable by the senses, more air is necessary. Unfortunately, persons living in houses where there are odors become accustomed to them and are not really aware of them. The sensibility of the nose becomes blunted. What is offensive to persons coming in from the open air is not noticed by them.

The modern mode of having the staircases in the middle of the house, thus removing the front from the back rooms, interferes with ventilation and renders the air almost stagnant. The so-called well-houses, with a column of damp, musty cellar-air distributed through the centre of the house, cannot but be injurious, especially as the top of the well is carefully covered over to prevent the escape of the air above, and to exclude the sunlight, as if its rays would cause blindness. It stops cross-ventilation through opposite windows—the readiest and surest means of removing impure air.

The warm air of the inside is of course lighter than the cold air outside; thus we have a constant interchange. The expanded interior air escapes, and the air from the exterior rushes in to establish the equilibrium. If the difference is very decided, the air moves rapidly, at five or six feet per second, and the current is unbearable if one's person is exposed directly to it. With care, however, this perflation can always be used. While we ventilate we must warm. By open fire-

places we do both, and healthfully. The aspirating action of winds produces upward currents of air through chimneys, and air is drawn in to supply the partial vacuum. Even if there is no fire, the chimney acts as a good ventilating shaft. It should never be closed by a fire board, no matter how ornamental it may be made. If cowls are put over the tops, they assist in aspiration force. *Open fireplaces ought to be in all rooms, especially where there are sick people, even if the rooms are otherwise heated.* The amount of air found going up chimneys is a most reliable index of the fresh-air supply. They draw the air in through every chink and hole and corner, and even through the walls themselves. The weather-strips, as they are called, used to prevent air from entering around the sashes, ought to be prohibited by law.

Unoccupied rooms ought always to have the windows open, unless the temperature is so very low that it is impossible to heat the atmosphere by the time they are needed. Let it be done as far as it is possible. Some outside air ought to be allowed to come into bedrooms throughout the night, unless the temperature gets below 50° in winter. Bedrooms should invariably be supplied with a magazine of fresh air before bedtime.

The windows of dining-rooms ought invariably to be thrown open after meals, and they ought not, if it can be avoided, to be occupied at other times. During the night the windows of the halls, dining-rooms and kitchen should be kept open, so as to let in a supply of fresh air and carry off impurities collected during the day. Over the front doors there is generally a transom, which can be put on hinges and kept open in the daytime as well as by night. Or there are small windows on either side of the front door which can be opened or shut at pleasure. If necessary, panels can be cut out of the door itself, and ornamental iron gratings substituted for the wood, and glass on hinges put inside. If, in addition to this, windows on the passages in the upper stories are kept open, we can have an ample quantity of fresh air passing through the halls. If this was done habitually, we would not have the musty atmosphere of halls loaded with organic matters, which so frequently annoys us as we go from the fresh air into boarding-

houses, hotels, and many private houses. Persons might then get some fresh air when they open their bedroom doors at night, instead of the polluted air they usually get.

The windows of bedrooms in winter should be opened as the occupants leave after dressing. It is a mistake to open them immediately on rising or while dressing, for the system is relaxed by sleep and fasting, and is easily impressed by the sudden change. If the outdoor air can be warmed properly as it enters by passing around the chimney, so much the better. If artificial holes can be made it would be advantageous, or if Arnott's valves could be fixed in the chimneys; but in most private dwellings we must rely upon the windows. True, more fuel must be consumed. But is not the additional expense a small matter compared with the healthfulness resulting from it? *Fresh air is better worth paying for than even food; it is more essential to health.*

It must be borne in mind that the reckless opening of windows does not constitute good ventilation, although it will furnish us with an abundant supply of fresh air. Good ventilation consists in furnishing pure air, but without draughts. An almost imperceptible breeze moves at the rate of 18 inches per second, or one mile an hour. This is sufficient to renew the air unless the room is of very small dimensions. Opening a window in winter, owing to the expanded overheated air, frequently makes an unbearable draught; but even on the coldest day, generally a chink may be left open at the top. If the residents are protected from the column of cold air, there is no danger. A good plan has been suggested, of lifting the lower sash two or three inches, and substituting a piece of wood the whole length, and thus closing the opening. The air then enters between the sashes and passes upward towards the ceiling; it thus mixes gradually with the air of the room and there is no rapid current. Or better still, if a piece of wood be fixed to the edge of the upper sash when it is lowered, so as to direct the fresh air upwards. "Maine's patent window-ventilators" are based upon this principle, and are admirably adapted for practical use.

Official Sanitarian.

We have inspectors of houses as to the materials used, the thickness of walls, &c. Why can we not have a City Sanitarian — one who understands his science, whose duty it shall be to see that houses are constructed with due regard to the entrance and exit of air? He would see that the water-closets are placed in the best positions and are properly constructed. Certainly, such a person would not permit a water closet to be where the windows of the room do not open into the open air. He would insist that the foul air pipe should be inserted high up the chimney, or if that cannot be, that it be carried up straight to the top of the house; and above all, that Jennings' or some other well constructed basin and trap should be used, so that a large volume of water, by thorough flushing, should carry off at once the sewage, and the valve should keep the foul gases from rising and penetrating through the house. Many lives would thus be spared, and epidemic diseases prevented from spreading. *Neither diphtheria, scarlet fever, nor any other zymotic disease would make headway, if householders would only let plenty of fresh air and sunlight into their dwellings, and attend to their sewerage;* using also plentifully water with chloride of lime, copperas (3 lbs. to a gallon of water), or any other reliable disinfectant. We should be sure that the furnaces were supplied with air by pipes of large diameters from the external air, and not from the impure air of the cellars, to deteriorate still further the already impure air of the house. When houses are heated by hot-air furnaces, care should be taken to have water evaporated at every register.

Let us remember that the true use of carpets is to keep the feet warm, and where no one walks there ought to be no covering of the floor, for carpets and other woollen materials retain organic matters which are deposited from the atmosphere. These undergo changes and produce disease. Carpets, curtains, &c., also collect the products of disease itself—the virus of small pox, scarlet fever, diphtheria, typhoid fever, and similar diseases. Carpets ought only to be in the centre of rooms and halls. They should be taken up and well shaken and exposed

to the outside air several times during the season. *In sick-rooms the floors ought to be bare*, and all curtains of woollen material removed. Let the practitioner always insist upon open fires and sunlight in rooms where the sick are attended. Let him watch closely the temperature of the atmosphere, as well as that of the patients themselves, and see that the plate or cup containing food, especially milk, is not exposed to contamination by being uncovered. Above all, let the nurse see that all night-vessels contain disinfectants, and that the excrements are instantly removed from the room. The burning of sugar or pastiles to destroy odors is only the substitution of another odor and an addition to the impurities. *The open window and the current up the chimney are the only effective means of getting rid of the contaminations of the atmosphere.*

In conclusion, we entreat all, especially parents, to bear in mind that rebreathed air, or air deprived of its proper proportion of oxygen by any means, is not healthy; and, if it also contains organic matter and the results of combustion, it is beyond a doubt poisonous. Sooner or later its effects will be felt; if not in acute diseases, the constitutions of the inhabitants will be impaired and the seeds of organic disease be sown.

Nature intended that we should breathe only pure air, and by so doing we keep off disease and prolong life.